Interference:

Constructive Interference:

Crests from both waves overlap.
The path difference $\Delta r=\delta$ a multiple of the wavelength λ.

$$\Delta r=\delta=m\lambda,\ m=0, \pm1, \pm2, \pm3, \text{etc.}$$

The phase difference $\Delta\phi$ is a multiple of 2π:

$$\Delta\phi=0, \pm2\pi, \pm4\pi, \pm6\pi, \text{etc.}$$

$$\Delta\phi=2m\pi,\ m=0, \pm1, \pm2, \pm3, \text{etc.}$$

Destructive Interference:

Crest from wave 1 overlaps with trough from wave 2.
The path difference $\Delta r=\delta$ is an **odd** multiple of $\lambda/2$.

$$\Delta r=\delta=(m+1/2)\lambda,\ m=0, \pm1, \pm2, \pm3, \text{etc.}$$

The phase difference $\Delta\phi$ is an **odd** multiple of π

$$\Delta\phi= \pm\pi, \pm3\pi, \pm5\pi, \text{etc.}$$

$$\Delta\phi=(m+1/2)2\pi,\ m=0, \pm1, \pm2, \pm3, \text{etc.}$$

Conversion:

A phase difference $\Delta\phi$ (or $\Delta\beta$) of 2π corresponds to a path difference of one wavelength λ, therefore:

$$\Delta\varphi=(2\pi\ \Delta r)/\lambda=(2\pi\delta)/\lambda.$$

Interference from thin films:

a) The **wavelength in a medium** with refractive index *n* is $\lambda_n=\lambda_{VAC}/n$.

Phase change due to path difference:

$$\Delta\varphi=(2\pi\, n\, \Delta r)/\lambda_{VAC}.$$

b) In thin films, we also need to consider the **phase changes due to reflection**:

Serway, page 646 (Ch. 22):
When a wave travels from medium A to medium B and $v_A>v_B$, the reflected wave is **inverted** upon reflection.
When a wave travels from medium A to medium B and $v_A<v_B$, the reflected wave is **not inverted**.
The **transmitted** wave is never inverted.

For **light waves** (Serway, page 771, Ch. 27):
If the wave travels from medium 1 to medium 2 and
$n_1<n_2$: 180^o phase change. Low to high, phase change π.
$n_1>n_2$: no phase change. High to low, phase change no.

Example: Air/film/air interface: